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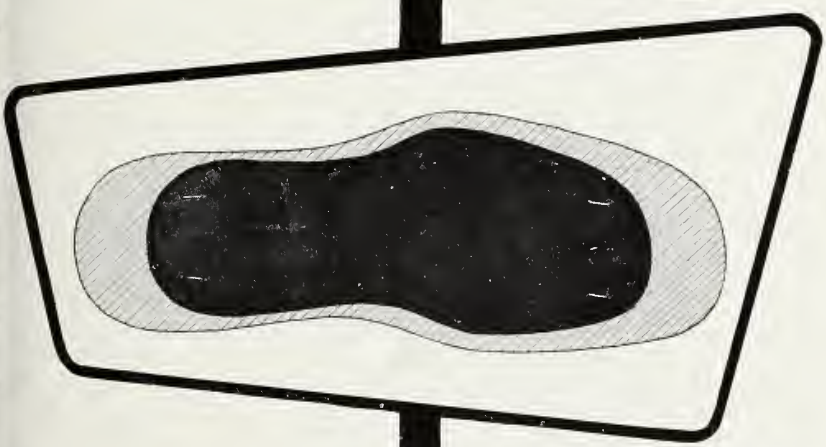

WHY LEATHER SHRINKS

Page 10

HOW A MOSQUITO REPELLENT WORKS

Page 8

GENES THAT DEFY TRADITION

Page 3

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CONTENTS

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New-uses team

The value of attacking complex questions with teams of scientists from many fields is well known. USDA goes still further with a team approach to all agricultural research.

That's why our utilization scientists—creating new uses and wider markets for farm products—work closely with scientists studying production, marketing, and consumption.

Production research gives us superior crops and livestock, better insect and disease control, more effective plant and animal nutrition, improved soil and water conservation, and advances in agricultural engineering. These developments affect the kind of crops and livestock produced as well as the efficiency of production. Thus, they affect the nature of farm products going to market and the price they bring. Marketing research likewise affects commodity availability and price, and consumption research helps us understand what individuals want and need. All these considerations shape the economic framework in which utilization research must be conducted.

Farm products have lost some markets to synthetics that offer unique characteristics or are priced more attractively.

But the complex constituents of farm products have unique characteristics, too, and we should be able to use them in creating new goods. Already, research shows that farm commodities can be used as raw materials for almost any product of the multi-billion-pound chemical and plastics industries. Furthermore, progress has been made in changing and improving the qualities that Nature put into our farm products—for example, leather, topic of an article on page 10 this month.

Utilization researchers, working as part of our agricultural research team, can give farm products the properties industry wants, develop new items that can't be made as cheaply or as well from other raw materials, and improve production efficiency so as to make farm products competitive.

Such a coordinated effort can not only strengthen industries now using farm products but also start new industries. It can give consumers new, better, and more economical goods. It can provide farmers new markets and greater demand for today's output and help keep future surpluses from piling up.

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CORN of intense-red plant color (right) crossed with nonred corn (left) gave normal Mendelian color array in progeny, but lost power to transmit own color in crosses with weak-red corn (center).

GENES that Defy Tradition

Some genes do change contrary to Mendel's law of gene purity in inheritance

■ TWO STUDIES ON CORN plants have proved there are exceptions to one of genetics' oldest laws: that genes, the units of heredity, retain their original properties even when combined with unlike partner genes.

According to this law, discovered by Gregor Mendel in 1866, a gene never loses its identity, even though the characteristic it determines may be masked in one or several generations by a dominant partner gene.

In people, for instance, blue eyes may not show up in the children of a blue-eyed mother because the children have received from their father a partner gene (allele) determining *brown* eyes, and brown is dominant over blue. The gene for blue eye color, however, is not "lost" or altered by its combination with the allele determining brown eye color. If the blue-determining gene is paired in the next generation with another gene for blue eye color, or with an eye-color gene over which *blue* is dominant, the

TURN PAGE

GENES that Defy Tradition

(Continued)

ehild with these genes will have "grandma's blue eyes."

But genes that don't act according to Mendel's law have been found for the first time in corn plants.

University of Wisconsin Professor R. A. Brink demonstrated that a gene determining purple color in corn kernels was permanently modified in its effect by combination with certain alleles. A new, lighter shade of purple was produced by this gene in subsequent generations.

And USDA geneticist E. H. Coe. Jr.. found in corn a gene that is apparently converted by an allele into its likeness. The modified gene not only reproduces the plant characteristics of the converter but also has the property of converting.

The "converter" gene and the partner gene it affects control red coloration in the husks, leaf sheaths, culms (stems), and other parts of corn plants, in particular lines of corn known as sun-red. Normal gene B determines intense-red color, and the converter gene, called B′, determines weak-red color. Another allele. b, determines lack of red color.

Two red types were crossed

Coe, working at the Missouri Agricultural Experiment Station, Columbia, crossed plants of B′B′ background with plants of BB constitution. The F_1 (first filial) generation plants all resembled the B′B′ parents. Since each F_1 plant supposedly had the genetic makeup B′B, simple dominance of B′ over B could account for this. But simple dominance couldn't explain occurrence of *only* weak-red plants in the next generation (F_2).

According to the mathematical ratios first worked out by Mendel and since confirmed in almost 60 years of experimental and practical breeding, progeny of F_1 plants (the F_2 generation) should have had these genetic makeups: BB, B′B, and B′B′, in the ratio 1: 2: 1. Assuming that B′, the weak-red color, was dominant over B, the intense-red color, this mathematical ratio would be expressed visibly as three weak-red plants to each intense-red plant.

Intense-red color was lost

But no intense-red plants had appeared in the F_2 generation. Chances for recombination of gene B with a partner B. instead of with B′. were 1 out of 4, and sufficient numbers of plants were produced to at least approach the ideal Mendelian ratio. What, then, could explain failure of intense-red plants to appear?

Before attempting to answer this question, Coe conducted further tests. He bred another generation of plants from the F_2 generation and also tried backcrossing and self-pollinating plants in which B had been combined with B′. But all attempts to recover B from such plants failed.

Two other experiments convinced Coe that these unusual results must mean a permanent conversion of B to B′, with the converted gene assuming all properties of its converter.

The first experiment tested the possibility that cytoplasm—the substance surrounding the cell nucleus—had modified the effect of gene B. Genes are located on chromosomes within the cell nucleus, and some cases of modification of gene effect have been attributed to cytoplasmic influence of the maternal parent (AGR. RES., April 1959, p. 5).

Coe therefore used B′B′ plants as pollen donors (male parents) in crosses with BB plants. This meant that most of the cytoplasm contributed to the embryo plants of the next generation would be from the maternal parent with BB genes. Progeny of such crosses were, however, all weak-red plants, and backcrosses to the original maternal parent (BB) continued to produce only weak-red plants. Crosses of B′B′ as pollen donor to four different strains of sun-red (presumably four different cytoplasms) also produced only weak-red plants through three generations. Thus, modification of B couldn't be accounted for as a cytoplasmic effect.

The second experiment was made to see if an irregularity in transmission of the chromosomes might be causing loss of expression of gene B.

The first step was to test behavior of B′ in combination with b, the allele determining lack of red color. Crosses between B′B′ and bb plants segregated normally for dominant weak-red and recessive green plants in both the F_2 generation and in backcrosses to bb plants. If only weak-red plants had appeared in these crosses, it might be suspected that gene B′ was transmitted to the next generation to the exclusion of *either* of its alleles. Normal transmission of the chromosomes was further confirmed by tracing inheritance of traits controlled by other genes on the same chromosome as b. These "marker" traits showed up as expected.

B gene was converted to B′

The next step showed that loss of expression of gene B was not due to irregular transmission of either the chromosome carrying B or the chromosome carrying B′, but rather to conversion of B to B′.

Coe crossed BB plants with B′b plants. If chromosome behavior were normal, the expected results of this cross would be half intense-red plants (Bb) and half weak-red plants (B′ and B converted to B′). This did happen. Selfing these plants showed

that the intense-red characteristic could be recovered only from plants in which B had been combined with b. The weak-red plants continued to produce only weak-red progeny.

Change proved permanent

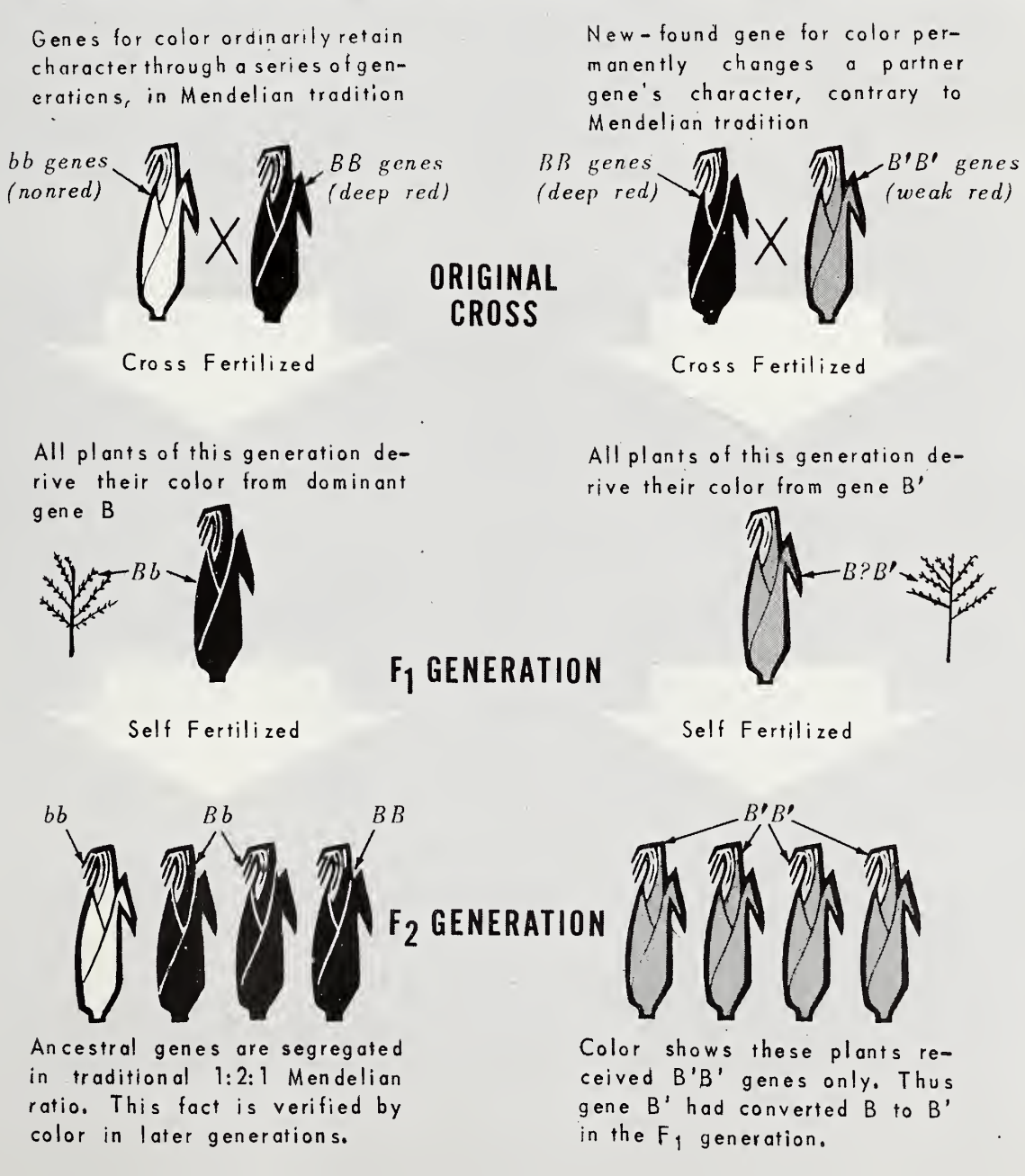
As another check on chromosome transmission, Coe is planning further tests, using "marker" traits on the chromosome carrying B.

All of Coe's tests have shown that gene B is permanently converted to B′. As he puts it, the change to B′ is "monotonously constant." Converted B regularly converts newly introduced B. This is shown especially by backcrossing to BB plants.

How one gene could permanently change another isn't known, but Coe and Brink have shown this happens.

These "firsts" in genetic history add to our basic knowledge of the properties of genes and may give clues to further understanding of how genes act and interact to determine hereditary characteristics. ☆

How the Surprising CONVERTER GENE Changes Corn Plant Color



LEVEL IRRIGATION IS EFFICIENT

■ IRRIGATION OF LAND made level by grading, a development of USDA agricultural engineers in the Southwest, is giving farmers more efficient use and control of water.

ARS agricultural engineer P. E. Ross at Weslaco, Texas, one of the developers of the idea, explains that the method involves leveling land and enclosing it in low ridges to confine rainfall or irrigation water.

Heavy rainfall is held until stored or evaporated, thus assuring maximum use. Irrigation water distributes evenly and percolates deeply to a uniform depth without adding water to the water table. This results in uniform seed germination and plant population and, of course, heightened production. The system is very efficient. Up to 90 percent of the water applied is used, in contrast to runoff and erosion losses as high as 70 percent with graded irrigation.

Leaching for salinity control also works well with level irrigation, because the water remains uniformly deep until it soaks in or evaporates.

The system takes less labor, too—with underground pipes, the only labor involves opening and closing valves. Precise stream size adjustments are unnecessary. ☆

BORDERS HOLD WATER to an even depth on this leveled field until the water soaks in. This assures uniform irrigation. Field is seeded to grass and alfalfa.

ROW CROPS ON RIDGES are irrigated without furrow erosion on a leveled field. Cotton (shown here) and other row crops benefit from level irrigation.

SOME LIMING BOOSTS PECAN YIELDS

■ CONTROLLED LIMING of pecan orchard soils helps make nut production more profitable and does not induce rosette, a disease caused by zinc deficiency, according to findings from recent USDA research.

Declining nut yields can be traced to increased soil acidity caused by using more acid-forming fertilizers and winter legume cover crops on orchards. As soils become *too acid*, calcium, magnesium, and potassium deficiencies occur in the trees and yields drop.

Pecan growers frequently hesitate to apply lime to correct this excessive soil acidity, even on the basis of soil tests. They believe that lime encourages the develop-

ment of rosette by making the zinc unavailable to the trees. Rosette results in tree-growth malformations, die-back, and reduced nut production.

ARS soil scientist J. H. Hunter, at Albany, Ga., showed that liming enough to correct *excessive* soil acidity helps more effective use of acid-forming fertilizers and winter legume cover crops. That gives more profitable yields. Hunter thus increased average annual nut output 3-fold and 4-fold on test plots.

To increase yields, Hunter applied annually 10 pounds of sulfate of ammonia per tree on some plots, and 8–8–4 mixed fertilizer on others. All test plots also received a total of 15 pounds of zinc sulphate per tree in the first 3 test years.

Rosette was cleared up in 2 years, but yields were unsatisfactory through the sixth year, at which time lime was applied at rates indicated by soil analysis. Five years after lime was applied, yields were seven to eight times greater than before.

Hunter's results are borne out by experiments in Alabama, where the combined use of lime and zinc sulphate provided better yields and controlled rosette.

In both instances, the research results are applicable to pecan orchards on light-textured, acid soils in 12 southern and western States. These States produce from 125 to 200 million pounds of pecans a year.

Hunter's experiments showed that lime should be applied before the lower layers of soil become too acid. Surface liming, he found, acted slowly in correcting acidity at depths ranging from 8 to 30 inches below the surface. State agricultural experiment stations can help determine how much lime is needed. ☆

HELPING HAND on the TRACTOR

■ PRECISION ROW-CROP cultivation and more effective weed control are the goal of an automatic tractor pilot designed by USDA engineer L. A. Liljedahl, stationed at the University of Minnesota, St. Paul.

The pilot is a guidance unit that works through the power steering—subject to the driver's overall control—and makes much finer cultivator adjustments than most drivers can.

Feelers are mounted at the tractor's front to sense distance to the crop row. When the front wheels move too near or too far from the row, feelers activate switches and valves, causing power steering to turn the wheels into alinement, then straighten them to hold the tractor on course.

Liljedahl's big problem was finding simple, low-cost equipment to make the device feasible for the farmer. He began his search by deriving basic equations for design of simple steering controls of the on-off type. The equations were checked by analog computer that mathematically simulated performance of the device. Reassured, he then built the automatic pilot model now being field tested. ☆

LIGHTWEIGHT FEELERS mounted at front of tractor activate automatic pilot when tractor wheels are too near or too far from row; power steering alines wheels.

Partially engorged *Aedes* mosquito (note swollen abdomen) feeds on arm of worker.

HOW A MOSQUITO REPELLENT WORKS

New techniques help scientists find answers pointing toward improved control

MOSQUITOES ARE STILL WITH US, in spite of potent insecticides and other insect-destroying methods. So USDA entomologists are prying into the lives of these pests to find better ways to combat them.

Recent work at the ARS entomology laboratory at Orlando, Fla., has been directed towards finding out how a mosquito repellent functions. With radioactive tracers, entomologists are measuring a mosquito's ability to detect the repellent, and finding out what happens to a repellent applied to an animal's skin.

For testing the mosquitoes' reactions to repellents, an improved method of offering food was developed. Researchers replaced the human arm with a glass cylinder holding blood covered by a membrane. The mosquitoes could insert their beaks through the membrane to feed on the blood. Repellent was spread on the membrane or emulsified into the blood. When repellent containing radioactive tracers was used, counts of activity on the insects' beaks and feet showed whether they had been in contact with the membrane.

This new method has several advantages. It makes possible the use of radioactive tracers, which cannot be applied to a human being, and saves time and discomfort for researchers. Repellents can be compared under standard conditions—unaffected by differences between humans—and at a greater range of concentrations.

Diethyltoluamide, the most effective repellent tested at this laboratory, was used in these studies.

Work with tracers bears out field observations. Mosquitoes keep off and hover a short distance above skin freshly coated with repellent of adequate strength. Entomologists think the repellent vapor affects the mosquito's olfactory organs, but further work is necessary to establish the exact mechanism. As the repellent loses strength—or if a weaker concentration is used—the insects begin to land but leave immediately.

Then more and more mosquitoes land and remain on the skin, walking about or standing but not attempting to probe. Later, they touch their beaks to the skin as through about to bite but do not actually do so, probably because the vapor close to the chemical source is still strong enough to repel them. They may make such contacts in several places and they frequently stop and rub the beak with the feet as though to clean it. Eventually they begin to bite. In cases where they insert their beaks but do not take blood, the mosquitoes may be repelled by the chemical coming in contact with sensory organs of the mouth parts.

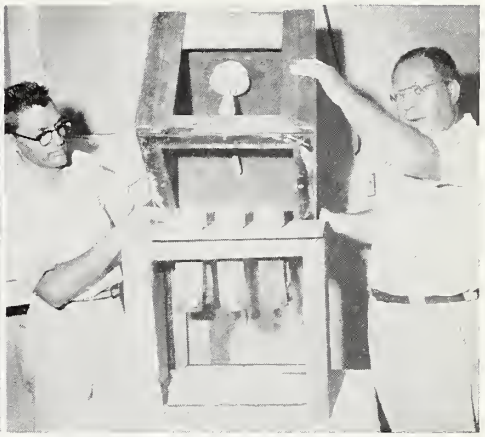
The researchers tried the repellent as a systemic by injecting it into rabbits and exposing them to mosquitoes. Practically all insects fed on the rabbits, showing that they had not been made repellent. Blood from other rabbits injected with the repellent was offered mosquitoes. More than 90 percent of the mosquitoes fed on the blood. These results indicate that an animal's body destroys or removes diethyltoluamide from the blood almost as fast as it is introduced.

Radioactive tracers were also used to study the fate of diethyltoluamide applied to skin of guinea pigs. Six hours after treatment, all pigs had lost about the same amount of chemical by evaporation. The amount not accounted for by evaporation or rinsing from the skin was assumed to be absorbed into the animal's body.

Finding Reactions of Mosquitoes

Measured amount of repellent from pette is spread evenly with glass rod er surface of membrane that form ttom of cylinder used to hold blood.

2. Blood warmed to 104° F.—with or without added repellent or radioactive tracer—is put into cylinder. Mosquitoes can feed on blood through membrane.

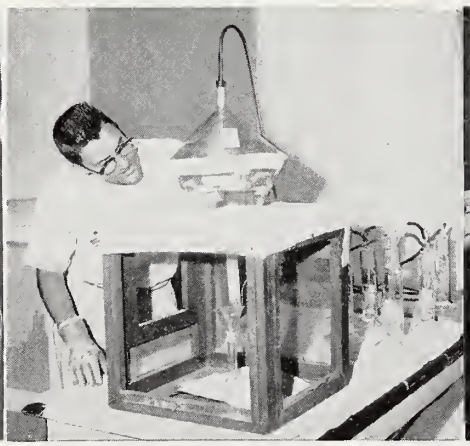


3. Top of incubator is lowered into place over filled cylinders to keep blood at constant temperature. Cylinders are put over holes in floor of incubator from which cages are suspended. Cages, containing adult female mosquitoes, are directly under cylinders. This allows mosquitoes to have free access to blood through membrane bottom.

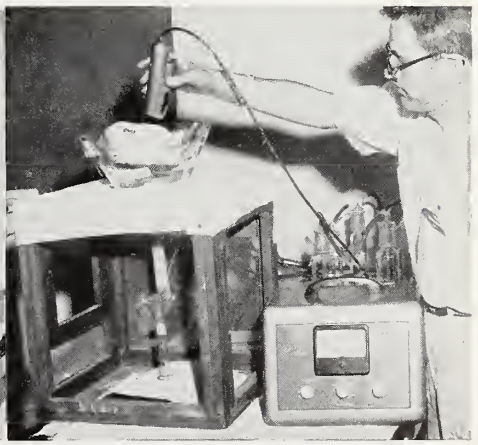
Most of the absorbed chemical was excreted in the urine. ne peak of radioactivity in the urine occurred within 12 urs, and over 80 percent of the absorbed dose was creted in 24 hours, 89 percent in 48 hours, and 93 to percent in 216 hours. Only about 0.75 percent was covered from the feces. Some radioactivity was found the hair that grew out of the treated skin. These findgs agree with those from earlier work using nonradiotive diethyltoluamide on humans. ☆

Finding Reactions of Animals

Radioactive repellent is applied to aved skin of guinea pig. After hours, pig's skin is rinsed to remove pellent not evaporated or absorbed.



2. Guinea pig is in metabolism chamber. Repellent vapor goes through pipe in top into alcohol traps at right. Urine and feces drop down funnel into container.



3. Geiger counter indicates radioactivity of guinea pig's skin. Radioactivity of vapor, urine, feces was measured by gas-flow proportional counter (not shown).

WHY LEATHER SHRINKS

Heat and liquid break down the helical structure of the molecule, causing melting and a change in dimensions

COIL STRUCTURE of the collagen molecule remains rigid under average temperature and moisture conditions encountered, keeping leather solid.

BREAKDOWN of structure occurs when bonds are attacked by excessive moisture or heat. This collapse is a phenomenon of melting, shrinkage.

■ LEATHER MELTS. This is the rather surprising explanation given by USDA scientists for its characteristic shrinkage in water.

Hide, whether or not it is tanned into leather, shrinks rapidly at certain specific temperatures when heated in water and some other liquids. Tanning makes the shrinkage temperature higher. How much higher depends on the kind of tanning material used, the conditions of tanning, and many other considerations. Shrinkage temperature of leather is recognized as one measure of its quality.

ARS chemists L. P. Witnauer and Jeanne G. Fee, of the Eastern utilization division, Philadelphia, were struck by the similarity of hide shrinkage to the behavior of similar polymers, such as plastics. These, of course, change their dimensions as they melt. Could it not be, the scientists asked, that hide shrinkage is also a melting phenomenon?

To a chemist, melting is a disordering of the molecules that make up crystal structure. If hide actually melts when it shrinks, heat and liquid together must attack the forces of attraction within the molecules.

We don't fully understand the crystal structure of collagen, the primary constituent of hide. We do know, however, that its molecules are arranged in the form of a regular coil, or helix. We can visualize collagen as a three-dimensional array of these coils, with hydrogen bonds between and within to form a stable structure of relatively rigid rods.

Liquids might attack bonds

Witnauer and Fee suspected that molecules of water or other miscible liquid get within and between these collagen coils and, at a given temperature, break the bonds holding them in their stretched, helical form. Thus the coils collapse and come apart, resulting in shrinkage.

There was a simple way to find out if this was actually taking place: determine whether the shrinkage temperature was affected by the amount of additive in the hide. If so, then the additive must act as a diluent, lowering the melting temperature in proportion to its concentration. Another familiar diluent, ethylene glycol anti-

freeze, acts that way. At low temperature, a mixture of water and its diluent, the antifreeze, may be solid. But the greater the concentration of that diluent, the lower the mixture's melting temperature.

Other scientists, working with single tendons of collagen, had provided some evidence for the melting theory. They found that collagen abruptly increased in volume (melted) at a specific temperature, and that adding ethylene glycol to the tendons progressively lowered this melting point. Witnauer and Fee duplicated these experiments with hide samples and discovered that they shrank linearly while increasing in volume. This occurred at about the temperature at which the collagen tendons increased in volume in the earlier tests.

Diluents break down molecule

Just as increasing the percentage of ethylene glycol steadily lowered shrinkage temperature, so did adding water, formamide, phenol, and certain other liquids. But some liquid additives, such as toluene, didn't alter shrinkage temperature. The latter liquids lack the capacity of the former ones to interact with groups in the collagen molecule. Here was proof that hide shrinkage is a melting phenomenon, and that it is produced by diluents containing a chemical group or groups that can interact with a group or groups on or within the constituent collagen molecule.

So raising shrinkage temperature of hide is simply a matter of limiting the amount of diluent that can associate with the helical coils of the collagen molecule. A tanning agent protects these coils, so that a given amount of diluent won't cause melting except at a higher temperature.

The chemists performed the same tests on tanned hide, using water as the diluent. They found the familiar pattern of shrinkage (melting) temperature being progressively lowered as water content of the hide increased.

This is true of all tanning materials. But the investigators were particularly interested in the vegetable tannins, which behaved in an unusual way. Melting temperature of vegetable-tanned leather was higher than that of untanned hide only with large contents of water. But at 20 percent moisture, for example, the leather melted at a temperature 55° F. lower than untanned hide. Removing all water by vacuum drying made the leather melt at 248° F., whereas untanned hide should melt at about 293° F.

Witnauer and Fee thus established that vegetable tannins *in themselves* actually lower the melting temperature of hide. A vegetable tannin is a diluent for collagen, just as water and ethylene glycol are.

Why, then, does vegetable-tanned leather shrink at a higher temperature than untanned hide when they are both immersed in water? Because this tannin gives the leather a higher temperature protection from shrinkage when immersed in another diluent, such as water. The tannin molecules mechanically block the water molecules from the helical coils of the collagen, just as any tannin does.

Tannin may lower melting point

With little or no additional diluent vegetable tannin reduces the melting temperature of leather to a point below that of untanned hide.

Other fundamental research on tanning will consider the effects of tanning on such leather characteristics as strength and flexibility. ☆

Protecting a Cheesemaker's Starter

■ CHEESEMAKERS CAN NOW BE much more certain of normal growth of the bacterial starter cultures they use in converting milk into cheese. USDA has developed a method of controlling bacteriophage, virus enemy of bacteria that convert milk to cheese.

ARS scientists at Washington, D.C., have found that costly starter failure due to the phages can largely be eliminated if the milk in which the cultures are grown is preheated in the presence of phosphate salts.

The phage viruses present in almost all cheese plants contaminate the bacterial starter cultures used to inoculate milk for cheesemaking. As the phage develops, it destroys the bacteria or hinders their vigorous, abundant growth, thus preventing development of the required acidity.

In the laboratory studies, various strains of cheesemaking bacteria were tested in milk with particular phages to which the respective strains are sensitive. The phages spread rapidly in untreated milk samples during a 24-hour incubation period and prevented growth of the bacteria. By contrast, the bacteria grew normally in all the samples treated with phosphate and heat. Three or four daily transfers of starter cultures in treated milk completely eliminated the phage. In pilot-plant tests, contaminated starters produced normal cheddar cheese from treated milk, but no cheese from untreated milk. ☆

Prolonged deficit causes deposits of excess calcium

HOW MUCH MAGNESIUM FOR CALVES?

■ WE'RE COMING CLOSER to a basic understanding of the magnesium needs of dairy calves on various diets as a result of long-range investigations at USDA's Agricultural Research Center, Beltsville, Md.

Scientists here determined recently how much magnesium growing calves need while on a diet of whole or synthetic milk or natural feedstuffs, and the incidence of calcification in the large arteries, muscles, and hearts of milk-fed calves. Feeding a milk diet to growing calves for a prolonged period causes below-normal magnesium levels in the blood, making some supplementation necessary. How much is necessary to prevent calcification has so far been uncertain.

Calves fed whole milk got only about 0.55 gram of magnesium per hundred pounds of calf weight and the magnesium in their blood decreased rapidly. On milk diets plus various amounts of a magnesium supplement, a daily magnesium intake of 1.1 grams per hundredweight was enough to maintain normal magnesium levels in the blood for a few months. An intake of 1.4 grams was effective for a few months longer. But an intake of 2.1 grams on a milk diet, or 0.9 grams on a diet of natural feedstuffs exceptionally low in magnesium—timothy hay, corn, urea—maintained normal magnesium levels in the blood for the entire year-long test. (Normal magnesium level is 2 milligrams per milliliter of blood.)

Study adds to basic knowledge

It's obviously impractical in most cases to raise calves on milk diets. And most diets normally fed growing calves contain enough magnesium. The value of these continuing Beltsville studies is in their basic contributions to a knowledge of magnesium utilization. Long-range investigations on mineral utilization are underway in this country and abroad.

ARS dairy nutritionists J. W. Thomas and Mitsuo Okamoto produced acute and chronic magnesium deficiencies in calves by putting them on milk diets containing various levels of magnesium, and by feeding them low-magnesium feeds.

Generally, length of life increased as magnesium intake increased. Weight gains of milk-fed calves were excellent except in those fed the lowest magnesium rates. And a chronic deficiency of magnesium in an otherwise good diet ultimately showed up in a sharply reduced rate of gain followed by convulsions and death.

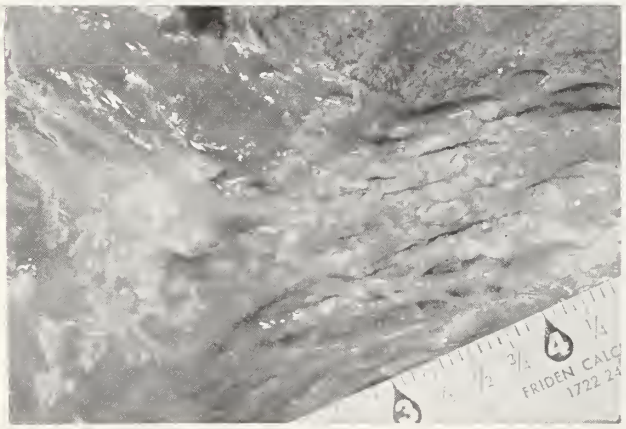
Concentration of magnesium in the bones increased as intake increased. Magnesium intakes of 1.1 grams per hundredweight and less in milk diets resulted in lower than normal amounts of magnesium in the bones. At this and lower levels of intake, the amount of magnesium in bone decreased as the animals grew older.

Highest incidence of calcification in the large arteries and heart was found in calves fed milk diets furnishing 0.5 or 0.8 gram of magnesium per hundredweight. Calcification was *never* found in calves fed milk diets furnishing more than 1.4 grams magnesium per hundredweight, calves fed diets consisting entirely of natural feedstuffs, or in calves less than 100 days old. Scientists believe it takes a long period of just-below-normal magnesium intake to cause calcification.

Age, breed affect calcification

The incidence and severity of calcification were influenced by age and breed. Older calves were more seriously affected than younger ones, Jerseys and crossbreeds more so than Holsteins. Supplementing the diet with tocopherol or vitamin D had no effect on calcification.

In these trials, the magnesium in natural feedstuffs was apparently utilized to a better extent than the magnesium in milk diets. In other experiments when milk was fed all the time, there was no difference in utilization of magnesium when natural feeds or magnesium salts were used as a magnesium supplement. Results of both trials suggest that there are other important factors regulating magnesium utilization. Work now in progress, for instance, suggests that the calcium-phosphorus-magnesium ratio may be important in determining optimum magnesium utilization. ☆



BONY DEPOSITS, or calcifications, as they're called by scientists, show up in heart of calf on a low-magnesium diet. The deposits also appear in large arteries, muscles. Deposits develop only after prolonged subnormal intake of magnesium.

INFANTS' NEEDS for LINOLEIC ACID

With adequate amounts, less food is required to satisfy infants' appetites but usual weight gains are maintained

■ THE OPTIMUM LEVEL for linoleic acid in infant diets seems to be about 4 percent of the calories—the level found in human milk—USDA contract research shows. Linoleic acid (an essential fatty acid) serves such vital functions as keeping skin healthy. Because the body cannot manufacture it, linoleic acid must be supplied in food.

Human milk contains more linoleic acid than cow's milk, and the studies suggest that this may account, in part at least, for its superiority over cow's milk in infant feeding. In the past, cow's milk and other substitutes for human milk have been modified and fortified to make them similar to human milk in vitamin, protein, mineral, carbohydrate, and total fat content. However, the fatty-acid content has not been adjusted, even though human milk contains several times as much linoleic acid as cow's-milk formulas used for infants.

At the University of Texas School of Medicine, researchers studied relationships between the infants' intake of linoleic acid and the amount of dienoic, trienoic, and tetraenoic fatty acids in the infants' blood serum, as well as their clinical condition.

The researchers gave the babies all they wanted of various forms of cow's-milk formulas or human milk. Some diets were supplemented with linoleic acid so that intake ranged from 0.1 to 8 percent of total calories.

Blood serum reflects linoleic-acid intake

The amount of dienoic acid in the infants' blood serum reflected closely the linoleic-acid intake. In general, as linoleic-acid intake increased, so did the serum dienoic and tetraenoic acids. Trienoic acid, however, decreased with higher levels of linoleic acid and increased with lower levels. This relationship was not affected by the level of total fat in the diet.

The researchers considered the infants to have *minimum normal* serum levels of unsaturated fatty acids when dienoic acid made up about 10 percent, trienoic acid, 3 percent, and tetraenoic acid, 7 percent of the total fatty acids. These levels were obtained when the infants were fed evaporated-milk formulas, with linoleic acid comprising about 1 percent of the calories. Clinical experience shows infants keep in healthy condition on this diet.

Optimum serum levels were believed to be about 24 percent for dienoic acid, less than 1 percent for trienoic acid, and 10 percent for tetraenoic acid—the levels obtained when human milk was fed.

The infants' food consumption varied with the amount of linoleic acid in the diet. As linoleic-acid intake increased or decreased, the infants' food consumption changed in the opposite direction. On extremely low linoleic-acid intake—0.1 percent, in a skim milk formula—some babies demanded enough formula to furnish 155 calories each day for each kilogram of their weight. On 1 percent linoleic acid (in an evaporated-milk formula), they consumed enough to furnish about 105 calories, and at the 4-percent level (human milk), an amount that furnished only 85 calories per kilogram.

All infants kept up the same growth rate

Yet all infants maintained the same rate of growth, indicating that at higher linoleic-acid levels they could make more efficient use of their food intake. However, the experimental period was short; longer periods might have revealed some effect on the growth rate.

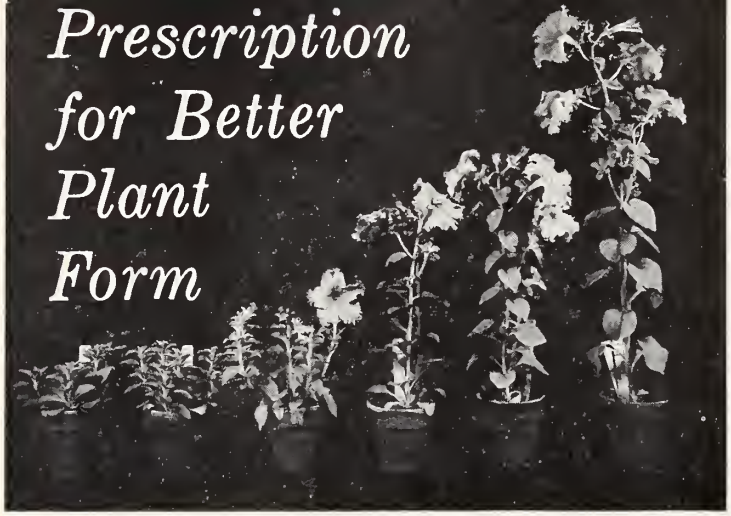
Although the caloric intake was in the normal range when linoleic acid made up 1 percent of the calories, caloric intake was less per unit of gain in weight when linoleic acid made up 4 percent of the total calories. This substantiates the finding from blood-serum studies that a 4-percent linoleic-acid intake is more nearly optimum than 1 percent for healthy young infants. Results were the same for infants receiving 8 percent linoleic acid as for those getting 4 percent, indicating that 4 percent was probably adequate for the infants' needs.

At present, the same researchers are studying serum fatty acids in *newborn* infants and their mothers. These infants, before feeding, have different proportions of fatty acids in their blood serum than their mothers at parturition (delivery) or infants that have been fed. Newborns show low dienoic and trienoic acid values—about the same as those of infants kept on evaporated-milk formulas. On the other hand, the tetraenoic acid in newborns' serum is high—higher than any values so far observed for other infants or children. The researchers suggest that the high values for tetraenoic acid in newborns may reflect the storage of a metabolite that is essential for nutrition during early life.

Cholesterol and total fatty-acids levels are relatively low in newborns as compared with those in their mothers.

Study is continuing on effects of a mother's diet during the last 3 months of pregnancy on her blood serum fatty acid values just before, at, and after parturition, as well as those of her infant at birth. ☆

Prescription for Better Plant Form



EFFECT of daylength on branching and blooming is shown in Ballerina petunias grown, left to right, on 8, 9, 10, 12, 14, and 16 hours of light.

Growth-modifying chemical keeps petunias compact while daylength controls induce branching and early blooming

■ THOSE BRIGHTLY COLORED petunias that bloom in your garden or flower box all summer may soon look better than ever. As part of basic studies on the effects of light and growth regulators on our crops and plant species generally, USDA scientists found that both daylength controls and a growth retardant can help produce compact, bushy petunias for bedding purposes.

Right now, the blossoms of petunias make a pretty display, but some varieties tend to have long, ungainly stems and few side branches. Commercial growers induce branching in these varieties by pinching off main stems, but little can be done under present growing methods to produce short-stemmed, more compact plants.

The ARS studies, however, showed that a combination of daylength controls and application of a growth retardant can produce the desired branching and compactness, make plants bloom earlier, and eliminate the time-consuming process of pinching.

Physiologist A. A. Piringer and horticulturist H. M. Cathey, at the Agricultural Research Center, Beltsville, Md., studied the effects of daylength, temperature, and the growth retardant Phosphon D, on seven varieties of petunias. They found branching was induced by growing seedlings on short days (10 hours of daylight or less)—the required number of short days depending on the variety. For example, 6 weeks of short days from time of seeding was about right for Ballerina, but 8 weeks was necessary for Cotton Candy.

After plants branched, placing them on long days (from 12 to 16 hours of daylight) induced blooming. It has been known for some time that long days hasten flowering of petunias, but this also causes unwanted lengthening of plant stems. Here's where the growth retardant helps. Plants grown in soil amended with Phosphon D had shorter stems, in proportion to the concentration of the chemical, regardless of daylength. And the growth retardant didn't affect flowering time. The longer the hours of light given, the sooner the petunias bloomed, and even naturally late-blooming varieties bloomed early with this treatment.

Incandescent light used to extend the natural day-length was more effective than fluorescent light.

Piringer and Cathey found cool nights (60° F.) also induced branching and shorter stems, the length of the stem being proportional to increasing temperature. Blooming, however, is delayed by low temperatures.

The treated plants are being grown in outdoor beds this summer to see whether they will remain short. ☆

STEM-SHORTENING effects of Phosphon D, added to the soil at the rate of 4 ounces to 100 pounds of soil, show in plant at right. Both plants were grown on 8 hours of light.

PLANTS grown under same light controls show increased compactness, left to right, with levels of 0, 1, 2, and 4 ounces of Phosphon D per 100 pounds of soil.

Aphid-resistant alfalfa

Cody, a new alfalfa that resists spotted alfalfa aphids, has been developed and released by USDA and the Kansas Agricultural Experiment Station, for growing in Kansas and possibly the entire Central Plains area.

Seeds should be available in 1960 for certified-seed growers. There may be a limited amount of seed for farmers. USDA will not have seed.

First aphid-resistant variety adapted to the Central Plains, Cody has antibiosis and tolerance types of resistance. That is, Cody gives no nourishment, recovers quickly from attempted aphid feeding. Other resistant varieties unfortunately are not adapted to the Central Plains.

Cody is a synthetic variety selected from a quarter million plants of Buffalo variety following screening for aphid resistance and progeny testing. Cody yielded as well as Buffalo, even in aphid-free areas. Because of the urgent need, Cody was increased and released after less field testing than usual.

Thimet fumigates fields

One of our newer systemic insecticides, Thimet—an organic phosphorus compound—kills insects on plants in an open field by fumes given off from the granules on the ground.

It has been known since 1947 that some compounds of this type would give a fumigation effect in greenhouses when the vents were closed, but the accumulation of Thimet vapor in field crops, to give satisfactory control, hasn't been reported previously.

USDA entomologist W. C. Cook observed this in 1957–58 studies of the pea aphid infesting alfalfa at Walla Walla, Wash. An application at the rate of 2 pounds per acre of the active ingredient Thimet killed aphids by fumes as long as 10 days after application. Thimet was being tested for its systemic action.

The killing action in 1957 was attributed to the chemical acting systemically through the plant. There was some uncertainty about this, however, since the dosage was quite low and the killing quite prompt for systemic action. But the 1958 experiments demonstrated the effectiveness of Thimet fumes, for many aphids were killed in untreated plots located randomly adjacent to and downwind of treated plots. Aphids in the upwind direction from treated plots survived.

Two States certified

Maryland and Nevada have been declared modified-certified brucellosis areas, joining 16 other States, Puerto Rico, and the Virgin Islands in achieving certification in the national fight against the costly disease of cattle. Certification means that not more than 1 percent of all cattle and 5 percent of all herds can be infected with the disease.

Progress reports show that the Federal-State cooperative campaign has cut the infection rate among all cattle blood-tested in the U.S., Puerto Rico, and the Virgin Islands from 2.6 percent in 1954 to 1.3 percent at the end of February of this year.

Milling v. amino acids

Wheat flour containing 84.9 percent of the whole grain was richer in all the amino acids studied than the flour milled at 71.5 percent, USDA studies show. Flour milled at 71.5 percent is customarily used for commercially baked white bread.

The amino acid values of the flour, dough, and bread were determined by microbiological assays. The amino acids studied were arginine, cystine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tyrosine, and valine.

The researchers found no gains or losses of amino acids from the fermentation process, whether the

doughs were made with or without yeast. Some losses of cystine, lysine, and methionine occurred during baking. The researchers also point out that the amino-acid values as determined in this case do not indicate to what extent nor which amino acids may have been "bound"—made physiologically unavailable—by baking.

Khapra beetle, again

The Khapra beetle—the world's worst pest of stored grain—has recently been found in El Paso, Tex., and environs. It was first found in this country in California in 1953 (AGR. RES., March 1956, p. 8). If left unchecked. the pest might spread easily throughout the country.

Immediately after the USDA Plant Pest Control Division found the beetle in an El Paso feed mill, a State quarantine was set up and an intensive inspection of other mills and warehouses in the area was undertaken. As of April 20, 17 infestations had been found in El Paso, 2 in Hudspeth County, Texas, 11 in the adjacent area of New Mexico, and 2 in nearby Juarez, Mexico.

The insect is difficult to eradicate because it can lie dormant for years

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and can reproduce at a prodigious rate. It can be carried unnoticed in grain sacks and other articles. Conventional spraying cannot reach it in tiny cracks in masonry and woodwork. Moreover, its life cycle is flexible enough to adapt to a wide range of climatic conditions.

The most effective method of eradication found so far is to quarantine premises and fumigate buildings, host materials, and exposed carriers. In fumigating, the entire building is made airtight by covering with gastight tarpaulin, and methyl bromide gas is circulated into every crack as well as through the grain.

Arrangements have been made to fumigate properties in Texas, New Mexico, and the Juarez infestations.

All earlier known infestations in New Mexico have been eradicated and only seven known infested properties remain to be fumigated in Arizona and California. Arrangements have also been made for handling all previously known infestations in Mexico.

Stones aid the soil

Removing stones from fields for easier machine harvesting of potatoes

and to lessen machinery wear has a flaw: It may increase soil erosion.

W. J. Grant, ARS soil scientist, and R. A. Struchtmeyer, University of Maine agronomist, found that taking stones larger than one-half inch reduces soil pore spaces and water infiltration, thus increasing runoff with soil loss nearly proportional.

Caribou and Thorndike soils, common in the Maine potato-growing area, contain coarse materials—particularly on slopes—and acquire in winter a pavement-like rock surface, which decreases erosion. This rock mulch disperses raindrops' energy and decreases soil surface sealing, thus increasing water infiltration.

Pioneering economics lab

A new Pioneering Research Laboratory—the 15th so far—has been established by ARS for basic research in the economics of interfirm integration in farming. The new laboratory, to be located in Washington, D.C., will be in the Farm Economics Research Division.

Interfirm integration in farming is concerned with ways and means by which production decisions, services, and risks are correlated between farmers and related businesses.

Objective of the new laboratory will be to analyze basic economic principles and related social and technological forces underlying development of the main alternative forms of integration and coordination in farm production. This will be done especially from the standpoint of farmers in relation to other stages in the production process. The purpose will be to understand better the economic reasons for the development of each form of coordination.

Two key agricultural economists have already been assigned to the new laboratory—R. L. Mighell as leader, and L. A. Jones. They'll cooperate in related research with the Agricultural Marketing Service and the Farmer Cooperative Service.

This curbs rose spot

Two new organic chemical fungicides, Phaltan and Cyprex, are giving nearly 100-percent control of black spot of roses, the Nation's most destructive rose disease.

In studies at USDA's Agricultural Research Center, Beltsville, Md., each fungicide was used in a spray with a miticide (Aramite or Malathion) and two insecticides, DDT and Lindane.

Fungicide action is not affected by the other chemicals.

Spraying was done weekly when the black spot was heaviest—from July 17 to September 17 in 1957 and from June 10 to September 9 in 1958. In the former year, no rose plants were injured, but last year growth was stunted with a spray containing Cyprex. The scientists haven't learned the reason for this difference.

The scientists will make further evaluations before rates of application are released to the public.

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